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EXTENSION BULLETIN NO. 9

# how to learn more about North Dakota's major natural resource through soil surveys

# SOIL

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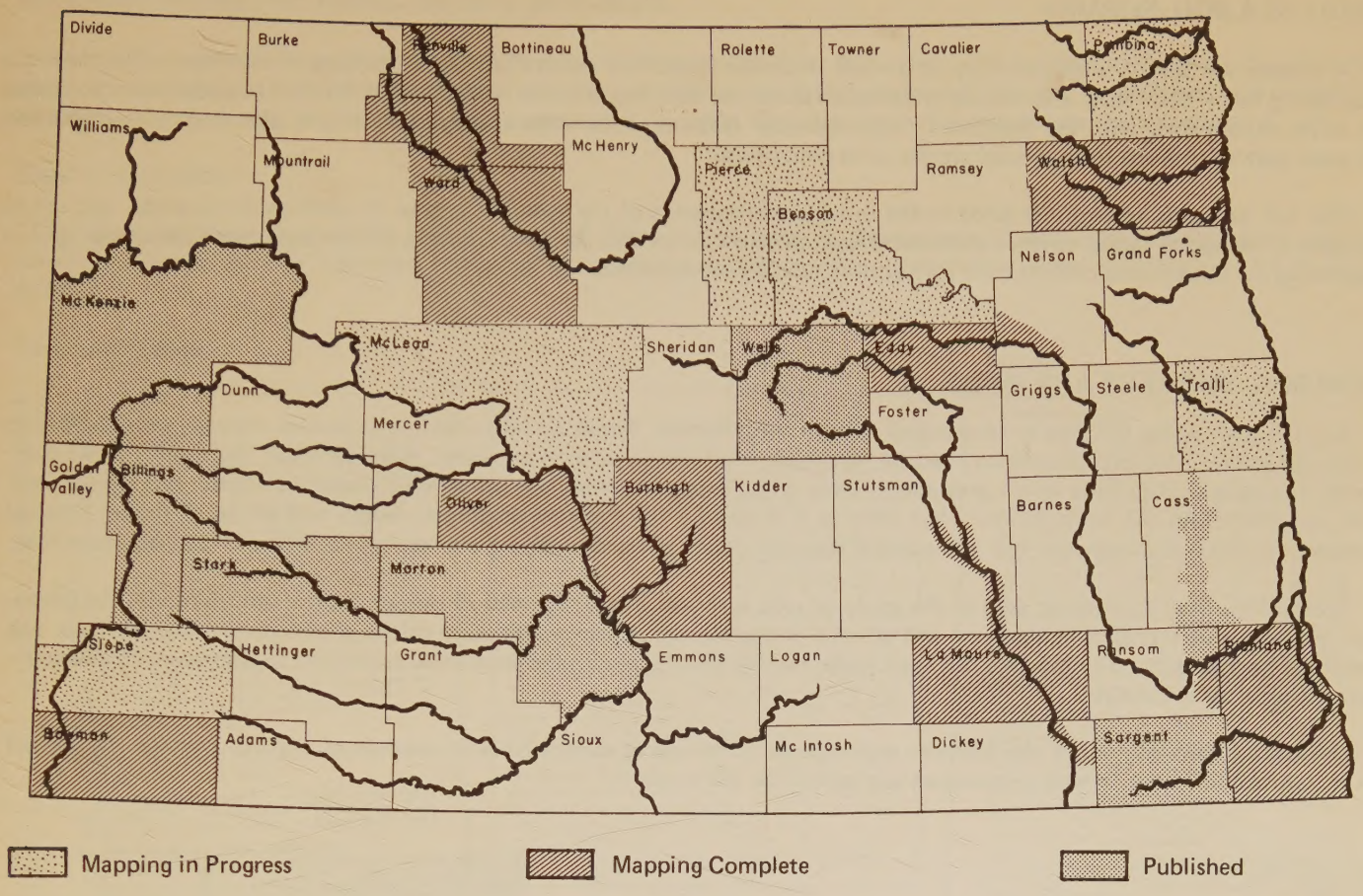
# Acknowledgement

*The author is grateful to Mr. Lloyd Shoesmith, state soil scientist (now retired); Mr. Lloyd L. Joos, assistant state soil scientist, Soil Conservation Service; and Mr. Hollis Omodt, professor of soils, North Dakota State University, for their assistance in preparation of this bulletin.*

*All photos taken by and used through the courtesy of the Soil Conservation Service, the Department of Agricultural Information and the Department of Soils, North Dakota State University.*

Cooperative Extension Service, North Dakota State University of Agriculture and Applied Science, and U. S. Department of Agriculture cooperating. A. H. Schulz Director, Fargo, North Dakota. Distributed in futherance of the Acts of Congress of May 8 and June 30, 1914.




## HISTORY OF

## NORTH DAKOTA'S SOIL SURVEY

The first soil survey of North Dakota land was published in 1903. From that time up to 1940 many counties or areas of North Dakota were surveyed, either as reconnaissance or detailed surveys, with results published on small scale maps. During the 1940's and early 1950's detailed surveys of McKenzie, Billings and Morton counties were published on small scale maps.

In more recent years since these original surveys were made, soils have been studied, correlated and mapped, using new, improved procedures. They are now mapped on aerial photographs which allow more detail and accuracy.

The first soil survey published in North Dakota using these new techniques was of Sargent County in 1964. Since then soil surveys were published of a Tri-County Area (portions of Cass, Ransom and Richland Counties in the Tri-County Irrigation District) in 1966, Stark County in 1968 and Wells County in 1970. Field work has been completed in nine other counties and mapping is in progress in six additional counties plus other small areas. The accompanying map shows the present status of soil surveys in North Dakota.

Two bulletins dealing with North Dakota soils have been published. These are Bulletin No. 472 "The Major Soils of North Dakota" and Bulletin No. 473 "Soil Survey Report-County General Soil Maps-North Dakota". They are available at a nominal fee from the Department of Soils at North Dakota State University.

Local Soil Conservation Service offices also have completed soil surveys made for individual farm plans available in many county areas. To obtain such soil survey information, published or unpublished, contact local Soil Conservation Service offices.

Soil survey work is done by the Soil Conservation Service in cooperation with the Department of Soils of North Dakota State University.

## WHAT IS A SOIL SURVEY

A modern soil survey is an inventory of the soil resources found in a county or area. It consists of a written summary and a map giving many basic facts and related information about the soils found in the area surveyed. The soil boundaries are indicated on aerial photographs, with the locations of other physical features of the landscape. Each soil area is identified by a symbol and all areas marked with the same symbol are the same kind of soil.

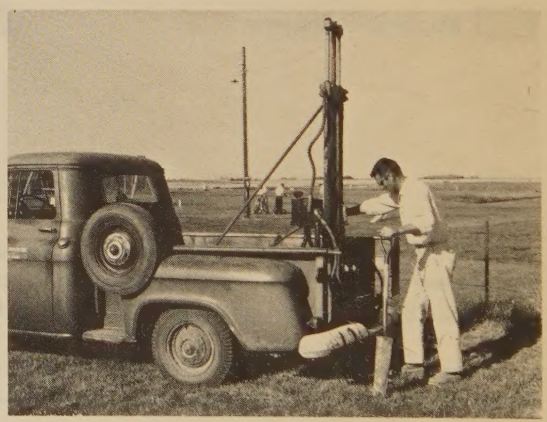
The soil survey is an essential guide to the use and management of the soils in the area. It contains information that can be valuable in managing farms, ranches and windbreaks; in selection of sites for roads, ponds, buildings or other structures; and in appraising the value of tracts of land for agriculture, industry or recreation.

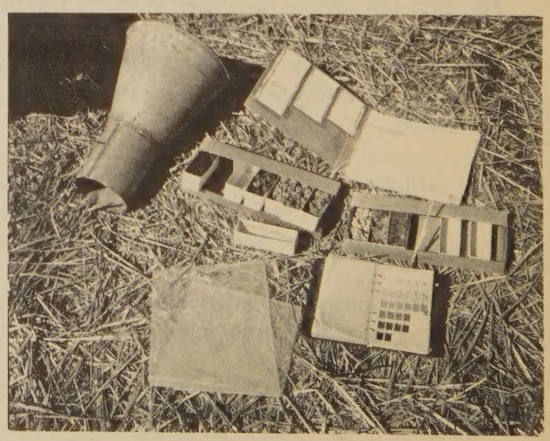
## HOW SOIL SURVEYS ARE MADE

Soil scientists study the area to be mapped acre by acre. As they travel over the area being mapped, they dig many holes and study the soil profiles, observing color; texture; structure; the kinds of layers; and other characteristics. These profiles are compared with other soil profiles in the area and in other areas. Using this procedure the soils are classified, named. and their boundaries are plotted on the aerial photo. They observe and plot on the map the steepness, length and shape of slopes. Physical features - streams, drainageways, etc. and cultural features - roads, railroads, schools, etc. also are located and plotted on the map.

Some of the field equipment used in the study of soils is shown below. Samples of the soil profiles are taken into the laboratory to make measurements of chemical and physical properties which can be related to characteristics observed in the field. The reverse is then possible. The scientist can then relate the chemical and physical properties proved in the laboratory to characteristics he observes in the field.

Soil profile descriptions and the behavior and response of the soil to various kinds of management (interpretations) are needed to go with the soil map. These are developed as a part of the soil survey.





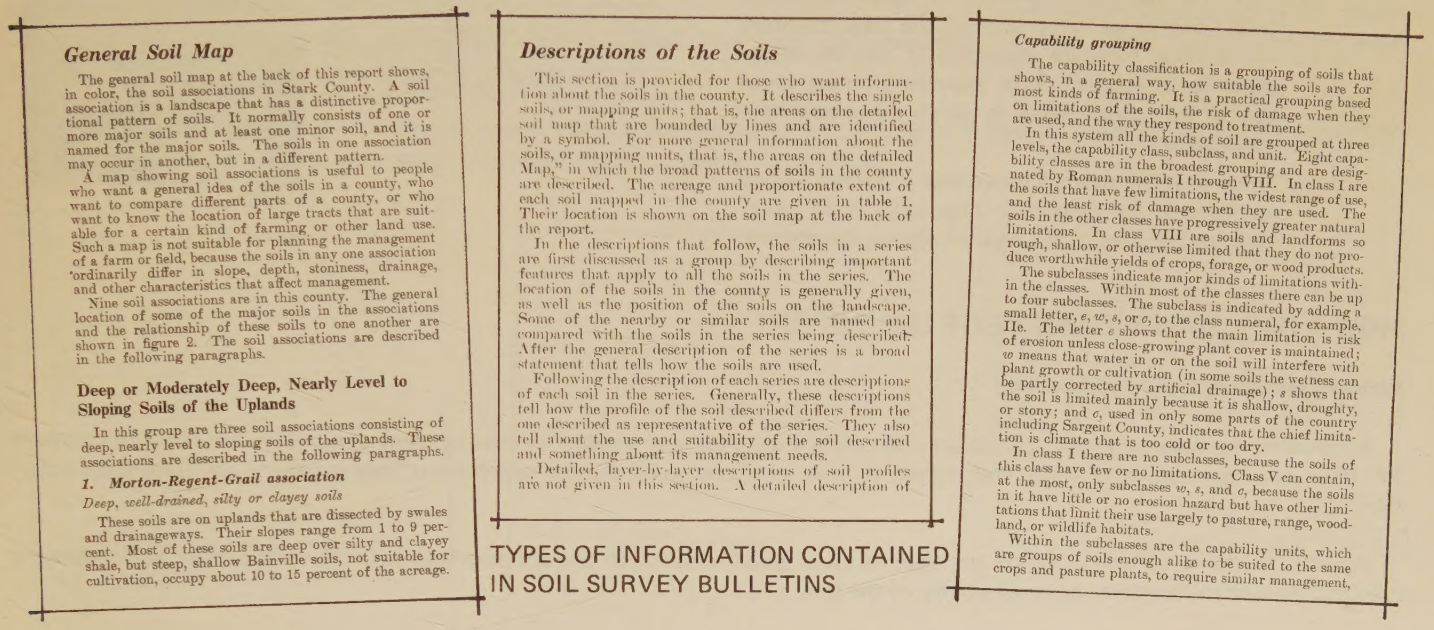
## INFORMATION CONTAINED IN SOIL SURVEYS

Information contained in soil surveys can be used by farmers and those who work with farmers; by foresters, by game managers; sportsmen and others concerned with wildlife; by ranchers and others interested in range; by engineers and builders; by scientists; by students, teachers and others interested in soils data and even by newcomers to an area.

### General Information

Pertinent information about the area is presented. This includes history, climate, type of agriculture, physiography, relief and drainage. Features such as highways, roads, railroads, bridges, buildings, mines, power lines, dams and pipe lines are shown on maps.

### Soils Information



*General Soil Map*

The general soil map at the back of this report shows, in color, the soil associations in Stark County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

Nine soil associations are in this county. The general location of some of the major soils in the associations and the relationship of these soils to one another are shown in figure 2. The soil associations are described in the following paragraphs.

**Deep or Moderately Deep, Nearly Level to Sloping Soils of the Uplands**

In this group are three soil associations consisting of deep, nearly level to sloping soils of the uplands. These associations are described in the following paragraphs.

*1. Morton-Regent-Grail association*

*Deep, well-drained, silty or clayey soils*

These soils are on uplands that are dissected by swales and drainageways. Their slopes range from 1 to 9 percent. Most of these soils are deep over silty and clayey shale, but steep, shallow Bainville soils, not suitable for cultivation, occupy about 10 to 15 percent of the acreage.

*Descriptions of the Soils*

This section is provided for those who want information about the soils in the county. It describes the single soils, or mapping units; that is, the areas on the detailed soil map that are bounded by lines and are identified by a symbol. For more general information about the soils, or mapping units, that is, the areas on the detailed Map," in which the broad patterns of soils in the county are described. The acreage and proportionate extent of each soil mapped in the county are given in table 1. Their location is shown on the soil map at the back of the report.

In the descriptions that follow, the soils in a series are first discussed as a group by describing important features that apply to all the soils in the series. The location of the soils in the county is generally given, as well as the position of the soils on the landscape. Some of the nearby or similar soils are named and compared with the soils in the series being described. After the general description of the series is a broad statement that tells how the soils are used.

Following the description of each series are descriptions of each soil in the series. Generally, these descriptions tell how the profile of the soil described differs from the one described as representative of the series. They also tell about the use and suitability of the soil described and something about its management needs.

Detailed, layer-by-layer descriptions of soil profiles are not given in this section. A detailed description of

*Capability grouping*

The capability classification is a grouping of soils that shows, in a general way, how suitable the soils are for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels, the capability class, subclass, and unit. Eight capability classes are in the broadest grouping and are designated by Roman numerals I through VIII. In class I are the soils that have few limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclasses indicate major kinds of limitations within the classes. Within most of the classes there can be up to four subclasses. The subclass is indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the country including Sargent County, indicates that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses *w*, *s*, and *c*, because the soils in it have little or no erosion hazard but have other limitations that limit their use largely to pasture, range, woodland, or wildlife habitats.

Within the subclasses are the capability units, which are groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management,

TYPES OF INFORMATION CONTAINED IN SOIL SURVEY BULLETINS

**Soil Associations Map:** This is a small map which gives a broad picture of the distribution of landscapes that have a distinctive pattern of soils that occur together. Each soil association in the survey area is discussed.

**Soil Series Description:** A soil series is a group of soils similar in all differentiating characteristics. Each soil series in the survey area is described.

**Interpretations:** These refer to the response and behavior of soils to various kinds of management. Soils with similar responses to a particular management often are grouped together. The most common interpretations are the land use capability classification, range site classification, woodland suitability, engineering classification and estimated yields of commonly grown crops for two management levels.

**Other Soils Data:** The aerial photographs or tables in the soil survey give information about the following:

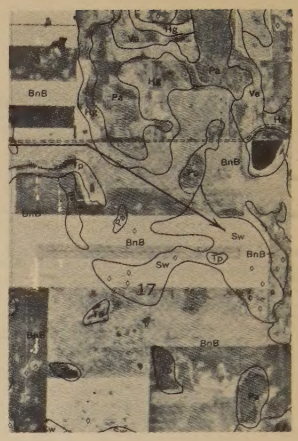
| | | |
|---|---|---|
| Soil boundaries | Soil reaction | Degree of erosion |
| Organic matter | Horizon color | Per cent slope |
| Alkali and saline spots | Horizon thickness | Rock formations |
| Structure | Subsoil permeability | Available water capacity |
| Soil type | Restricting layers | Salinity |
| Texture | Depth of root zone | Dispersion |

Information regarding management of soils under irrigation is contained in soil surveys of areas proposed for irrigation.

## FINDING INFORMATION ABOUT THE SOILS ON YOUR FARM OR RANCH

When you have the soil survey for your county, information about your farm can be located as follows:

1. Refer to the Index To Map Sheets page in the back of the report. This allows you to find the sheet number on which your farm or ranch is shown.
2. From the sheet number showing your farm area, determine the map symbols occurring on your land.
3. Refer to the guide to mapping units, capability units, and range sites to find the page numbers where these soils are described. It also shows the pages for capability units, woodland group, range site, or any other group in which these soils have been placed.
4. These give the needed references to locate recommendations for managing these soils under cropland, range, woodland and windbreak conditions.




**Svea-Barnes loams** (0 to 3 percent slopes) (Sw).—This complex occurs as nearly level areas on glacial till plains. Svea loam makes up about 60 percent of the complex, and Barnes loam about 40 percent. The Svea soil occupies the lower landscape positions, below the Barnes soil. Included in mapping were small areas of Hamerly, Parnell, and Tonka soils.

These soils have the profiles described as typical of their respective series. They have high moisture-holding capacity, and they are readily permeable to roots, air, and water. Runoff is slow. Erosion is not a problem.

Small grain, corn, flax, alfalfa, and tame grasses are well suited (fig. 9).

Management practices are needed to conserve moisture and maintain fertility. Stubble-mulch tillage, management of crop residue, establishing windbreaks, and fertilizing are beneficial practices. Trees for field and farmstead windbreaks are well suited. (Capability unit IIe-6; Silty range site: Svea part is in windbreak site 1; Barnes part is in windbreak site 2)

## HOW A SOIL SURVEY CAN BE OF USE TO YOU

**Farmers, Ranchers and Farm Managers**

It contains the necessary information on soils of the area to serve as a guide for development of conservation plans to maintain this basic natural resource in place, and protect it from wind and water erosion which contribute greatly to environmental pollution.

All soils found on a farm or ranch are mapped on an aerial photograph and are described with the management and treatment practices needed to maintain the productivity of the soil.

Estimated average acre yields of the principal crops grown in the surveyed area are given for prevailing and improved management practices.

Recommended grass and tree species are given for soil areas if they are to be used for pasture, hay or rangeland; or for windbreak sites.

Soil surveys of areas proposed for irrigation (for example, Tri-County Area) contain a discussion of management of soils under irrigation. They also contain tables giving irrigation ratings, limitations and management problems for each soil in the area surveyed. Information pertaining to expected yields under irrigation also is presented in such soil surveys. Some aspects of irrigation potential also are presented for all survey areas even though they are not proposed for irrigation.

To help the progressive farmer in using soil surveys to develop a conservation plan for his farm, several basic soil characteristics--such as soil type, slope of the area and degree of erosion--are converted into eight land capability classes. These classes help the farmer in determining the degree of farming hazard involved. There are few limitations on the use of Class I and II land while Class VI and VII land have severe limitations which should preclude them from cropland use.

The soil survey contains information on the suitability of soils for tame pasture and hay. Suggested species of grasses are listed for the various capability classes.

Range conservation information is presented by a discussion of:

1. Range sites. These are groups of similar range areas which because of climate, soil and topography are suited to specific grasses and management.

2. Range condition. Condition is a result of management and is determined by comparing present vegetative cover with potential native plant cover. Range condition is indicated by use of the descriptive terms excellent, good, fair and poor.

North Dakota presently has just over 12.5 million acres in pasture and range. It is estimated that about 50 per cent of this acreage could benefit from conservation practices discussed in soil surveys. The dominant conservation practices needed on these acres are protection from overuse and improvement of plant vigor and production. Proper grazing, fertilization and weed control would accomplish this on many of these acres.

It also is estimated that some 740,000 acres of North Dakota's land that should be in pasture or range is presently being used for cropland. Many problems result when land unsuited for cropland is cultivated.

**Use of the Soils for Tame Pasture and Hay**

Most of the soils in capability classes II, III, and IV are planted to cultivated crops each year. A considerable acreage of these soils, however, is used to grow grasses and legumes for hay and pasture. The pastures and meadows are used to produce forage to supplement that provided by the native range.

The areas in tame pasture and meadow are considered to be semipermanently converted from cropland. For those areas, periodic cultural treatments are needed in addition to proper grazing management. The soils may need tillage to prevent compaction or puddling of the surface soil. Occasionally, they need tillage, so that a seedbed can be prepared and the stand improved by reseeding the area. Applying fertilizer according to the results of soil tests is also important for maintaining the stand and producing forage. Mowing, scattering droppings, spreading water, and rotating grazing are all good management practices.

Introduced grasses and legumes make up most of the stand in the tame pastures and meadows. They generally consist of cool-season species grown for pasture and hay early in the growing season. Warm-season species are also grown, however, for grazing in summer and fall. The major species used for seeding are crested wheatgrass or smooth bromegrass, seeded alone, in mixtures, or with alfalfa.

Crested wheatgrass, Siberian wheatgrass, alfalfa, and sweetclover are the better species for seeding on the sandy and droughty soils of capability units IIIe–3, IIIe–3M, IIIe–3P, IIIes–3, IIIes–5, IIIs–6R, IVe–2, and IVe–3. In addition to these species, Russian wildrye, green needlegrass, western wheatgrass, and slender wheatgrass are suitable for the medium-textured and fine-textured soils in capability unit IIe–6, IIe–4, IIe–5, IIIe–4, IIIe–6, IIIs–5P, and IIIs–6R.

Bromegrass, western wheatgrass, intermediate wheatgrass, and switchgrass are suitable for soils that are irrigated or that receive supplemental moisture as a result of their position on the landscape. Creeping foxtail,

**Use of the Soils for Range**

Approximately 37 percent of the total land area in Stark County is in range. The soils in range are mainly ones that are not suitable for cultivated crops. Although some of the areas now in grass were formerly plowed and farmed for a time, the farmers soon learned that some of the soils are not suited to cultivated crops. They discontinued cultivation after a few years, and then, the kinds of plants that were in the original cover became reestablished. The land that was formerly used for crops is now generally termed "go-back" land. Most of the land that was formerly cultivated was abandoned for cultivation during the thirties. Some of the fields that were formerly used for crops now appear to be much like the surrounding areas of range that have not been plowed. Others can be distinguished easily because of differences in the vegetation.

As a rule, the only soils in grass that were not cultivated were the steep or stony soils or soils severely limited by a claypan, by extremely coarse texture, or by some other obvious characteristic that made them undesirable for farming. The resulting pattern of areas of grassland, therefore, is one which largely conforms to the general relief. Most areas of range are in the breaks that extend outward from the Heart, Knife, and Green Rivers. Smaller patches consist of areas of loose sand or sandstone ridges, knobs where scoria is at or near the surface, and flats where the soils contain a claypan. In a few places there are small, irregularly shaped patches of soils suitable for cultivation within the areas of soils not suitable for crops. The soils in these small patches escaped cultivation, mainly because they were not readily accessible, or because the landowner wished to block out a pasture where most of the tract was unsuitable for cultivation.

Most of the grassland in the county is used for grazing, except for small areas that receive additional moisture from runoff. Those areas are often mowed for hay. On some farms where the tracts in native grass are small and are surrounded by land used for other purposes, these small areas are used as a habitat for wildlife. Some income is derived from ranching or livestock farming on

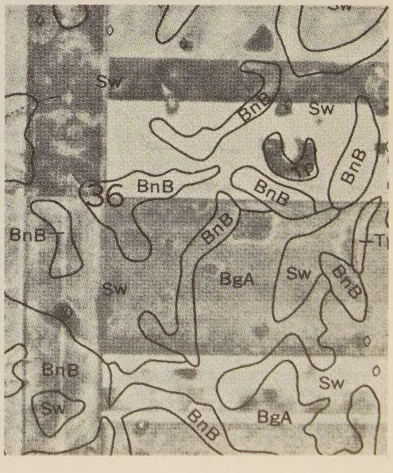
**Banks, Investors, Land Appraisers, Credit Agencies and Tax Assessors**

The soil survey shows the location and extent of all soils occurring in the county or area. It also describes them.

It contains sources of information needed for estimating the earning capacity of the different soils in the county or area. Such information is useful for credit purposes or investment feasibility.

The survey contains information useful in determining the possibilities of certain soil areas being used as building sites.

The detailed soil survey can be used as a basis for development of acre values for each kind of soil in the county or area surveyed. A fair tax evaluation for each property can be made using the detailed soil survey map as a basis for determining the acres of each soil type within the property.



**County Extension Agents, Vocational Agriculture Instructors and Educational Leaders**

Information contained in the soil survey is a basis for making recommendations on use of the various soil management practices, crop varieties, and grass and tree species.

Moisture storage ability, texture and other information given in the soil survey can be helpful in making fertilizer recommendations.

People involved in research use soil survey information in planning and locating sites for future research projects and in relating research results to areas where the problem identified by the research is likely to exist.

People working in land judging can use soil survey information as an excellent reference for training land judging teams.

Educational leaders will find information about soil characteristics and the management of these soils that can be useful in the education of students about this natural resource.

**Wildlife and Recreational Site Locations (Windbreaks, Woodland and Wildlife)**

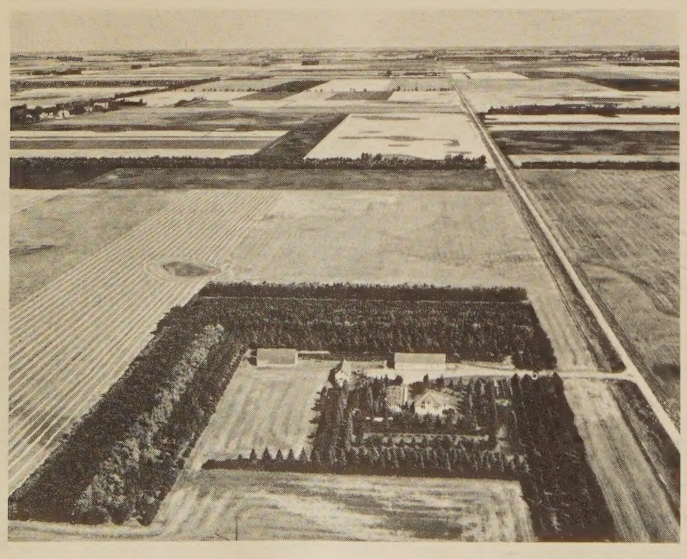
In the soil survey, soils in the county or area are given a rating of excellent, good or fair for growing trees. The preparation and maintenance of windbreak sites are discussed. Species of trees suitable for windbreaks are listed.

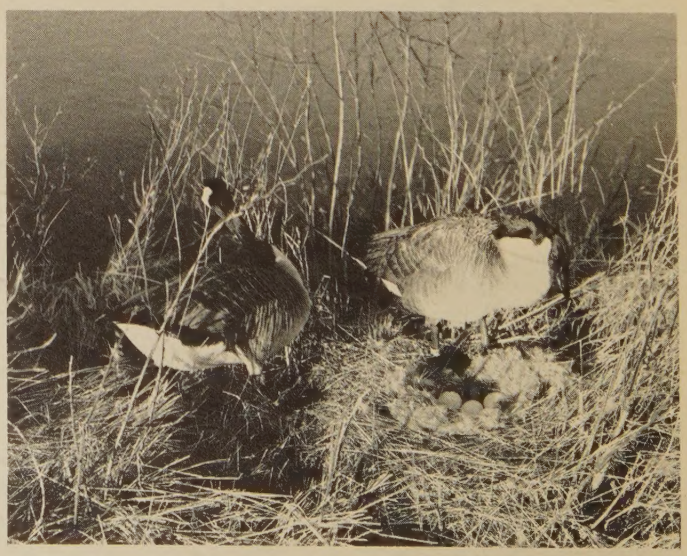
Some discussion of woodland uses is contained in the soil survey, although very little land area is in woodland in North Dakota. Estimated at 650,000 acres, most of it is considered to be adequately treated for conservation.

The management of soils for wildlife is covered in the soil survey. A discussion of the kinds and distribution of wildlife and how wildlife areas can be improved in the area covered by the soil survey is presented.

Soil information such as salinity classification and water table occurrence can be helpful in identification of areas more suited to wildlife than crops.

The soil survey is extremely useful in development of watershed projects.





### Engineers (Highway and Others)

The soil survey contains information on engineering systems used for classification of soils. Discussion and tables in the soil survey give information for each soil such as: 1) depth of profile, 2) classification, 3) percentage passing through different sieve sizes, 4) permeability, 5) available water capacity, 6) salinity, 7) dispersion, 8) shrink-swell potential, 9) susceptibility to frost action, 10) location of borrow pits, and 11) many other engineering aspects.

Such information can help engineers make plans, prepare designs, calculate construction factors, check soils for foundations, avoid areas subject to flooding, locate wet soil areas, determine drainage problems and identify other soil characteristics helpful in home, business and other types of construction. This information can be used by highway engineers to locate routes or roadways.

The soil survey discusses the suitability of each soil in the area surveyed as a source of road subgrade and road fill and as a source of topsoil fill, sand or gravel.

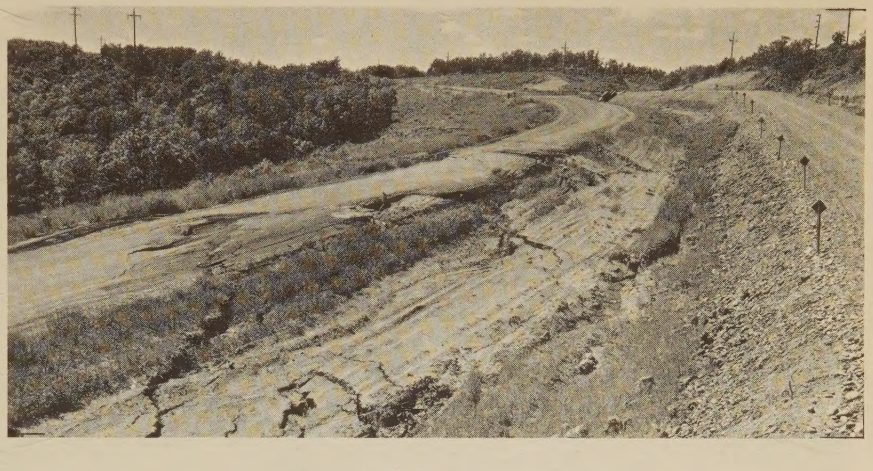
Engineers use the information to: 1) make soil and land use studies, 2) make preliminary estimates of engineering properties of the soils, 3) make reconnaissance surveys of soil and ground conditions, 4) locate probable sources of sand and gravel, 5) determine the suitability of soils for cross-country movement of heavy equipment, and 6) create awareness of hazards, limitations and useful properties of soils for engineering uses.

**Use of Soils for Engineering**

This section describes briefly two engineering systems for classifying soils, gives soil test data and interpretations, and discusses engineering uses of some soils. Most of the information is in tables 7, 8, 9, and 10. In table 7 are test data for 14 soils from which samples were taken. Table 8 describes the soils in Sargent County and gives estimates of their physical and chemical properties. Table 9 is an interpretation of the suitability of the soils for engineering purposes. Table 10 gives the location of borrow pits and estimates of the kind and amount of material available.

Other information useful to engineers can be found in the sections "Descriptions of Soils," "Formation and Classification of Soils," and "General Soil Map." The location and distribution of the soils in the county are shown on the soil map in the back of this report.

Technical terms used in this section, as well as in the rest of the report, are used in their agricultural sense, and are so defined in the Glossary. For some terms—for example, clay, silt, sand, granular, and aggregate—the agricultural meaning differs from that generally understood by engineers.



### Planning Boards, Health Officials and Municipal Officials

Soil data such as permeability, ground-water level, slope of the land, texture of soil horizons, presence of limiting layers and dispersion can be very useful in determining the suitability of soils for septic tank fields. Many of our soils are imperfectly or poorly drained and water moves through them slowly. Sewage soon clogs soil pores. Septic tank fields on such soils often back up or overflow, causing serious health problems. Soil survey information can be used to identify soils having persistently wet subsoils, soils subject to overflow or flooding and shallow or sandy soils which may allow detergents and other pollutants to enter the ground water.

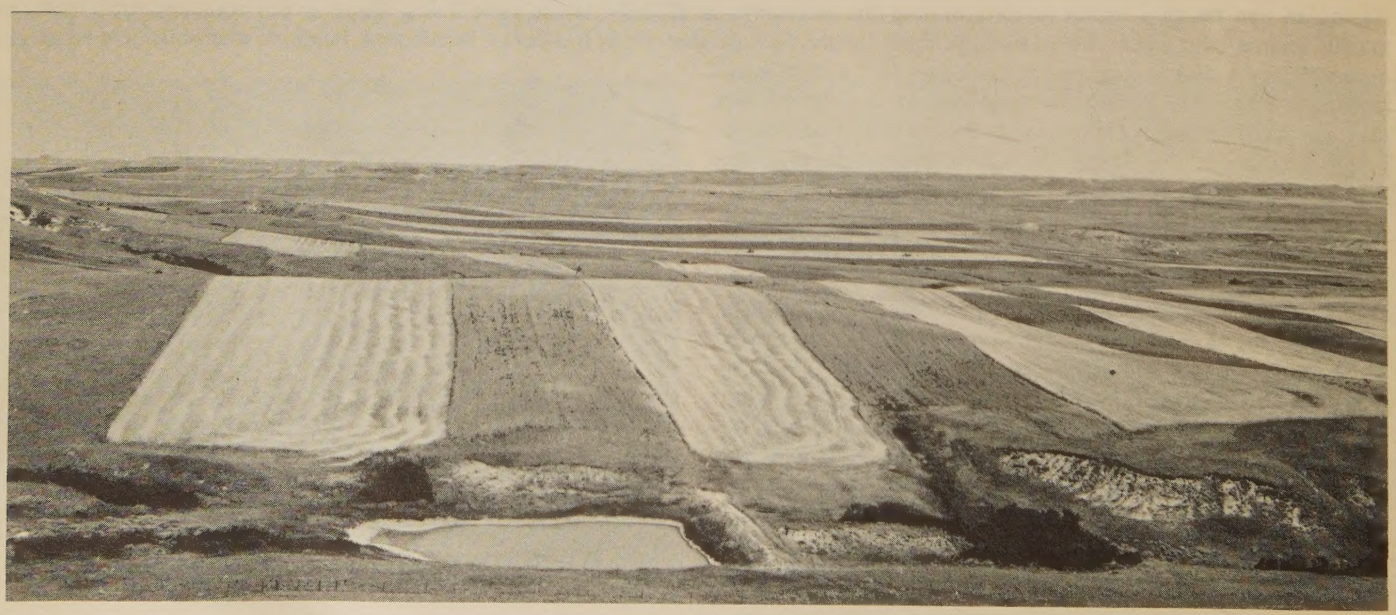
Information in the soil survey can be used as a valuable aid in zoning areas for various uses based on the capabilities and limitations of the soils contained in the area. It can help local zoning boards prepare a well thought out land use plan and zoning map by evaluating the suitability of each soil for agricultural, residential, industrial, transportation and recreation use. Land areas subject to flooding might be zoned to prohibit the erection of permanent structures. Such areas are better suited for wildlife habitat, recreation, open space or pasture.

Soil survey information also can be used to help officials determine private and public building and development plans.

## SOIL SURVEYS CAN HELP YOU TO BETTER USE AND PRESERVE ONE OF OUR NATURAL RESOURCES - SOIL

Local Soil Conservation Service offices have soil surveys and information concerning them which can be helpful to you. If your county or area is not presently included in any area which has had the soil survey published and you wish to learn something about the soils you work with, contact your local Soil Conservation Office. They can supply this information and acquaint you with conservation practices which help maintain and improve the productivity of our natural resource – soil.

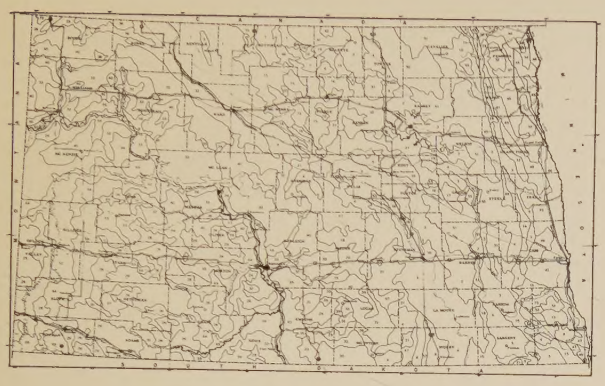
It took many years to develop the soil we are blessed with in North Dakota. This soil is an irreplaceable resource. Let us learn how to prevent losing it over a much shorter time span. SOIL SURVEYS CAN DO THIS. They are a basic scientific inventory of soil resources. They can provide valuable information needed for land use planning, highway location and design, park and open space planning, subdivision layout and design, planning and design of sewage disposal facilities, design tile drain systems around homes, zoning and other land use controls, as well as for their prime objective of agricultural land use planning and management. The proper use of land according to capability class and the utilization of conservation practices suggested in soil surveys for each land capability class can go a long way in reducing pollution caused by water and wind erosion of soils.



BULLETIN No. 472 January, 1968

# The Major Soils

## OF NORTH DAKOTA



By H. W. Omodt, G. A. Johnsgard, D. D. Patterson, and O. P. Olson

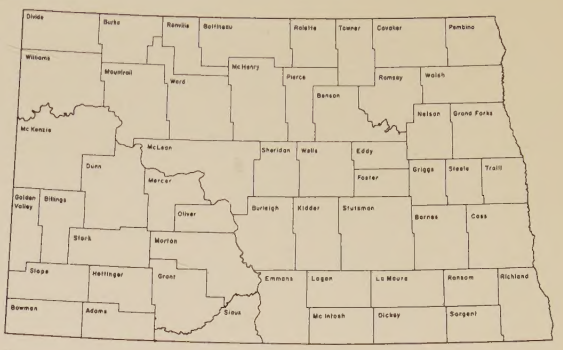
Department of Soils
AGRICULTURAL EXPERIMENT STATION
NORTH DAKOTA STATE UNIVERSITY
Fargo, North Dakota 58102

BULLETIN No. 473 July, 1968

# SOIL SURVEY REPORT

## COUNTY GENERAL SOIL MAPS

## NORTH DAKOTA

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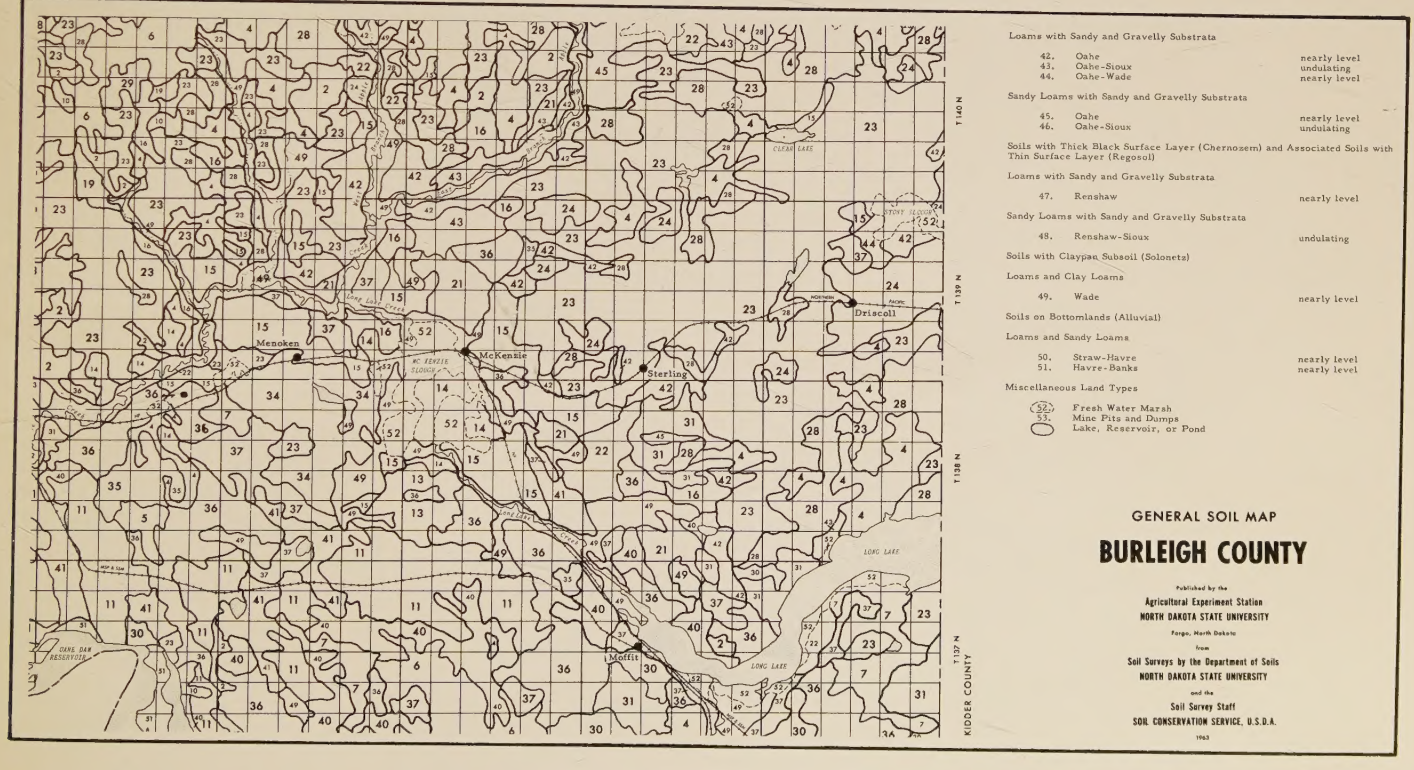


Illustrated above is other available reference material about North Dakota soils. These publications are available from the Department of Soils, North Dakota State University, Fargo, N. Dak. 58102.

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